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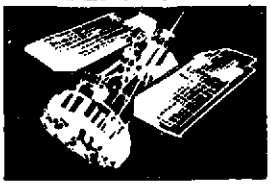
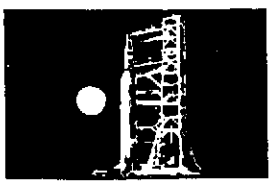
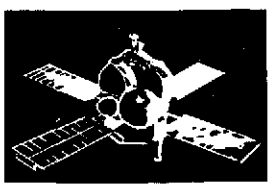
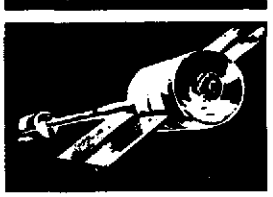
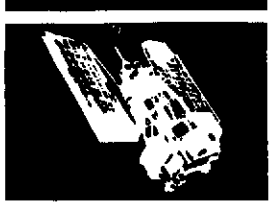
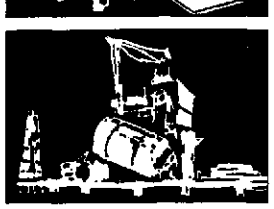
SPACE DIVISION



EARTH OBSERVATORY SATELLITE SYSTEM DEFINITION STUDY

Report No. 5
SYSTEM DESIGN AND SPECIFICATIONS

Volume 7
SPECIFICATION FOR EOS LOW COST READOUT STATION

Prepared for:
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Greenbelt, Maryland 20771

Under
Contract No. NAS 5-20518

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GENERAL ELECTRIC

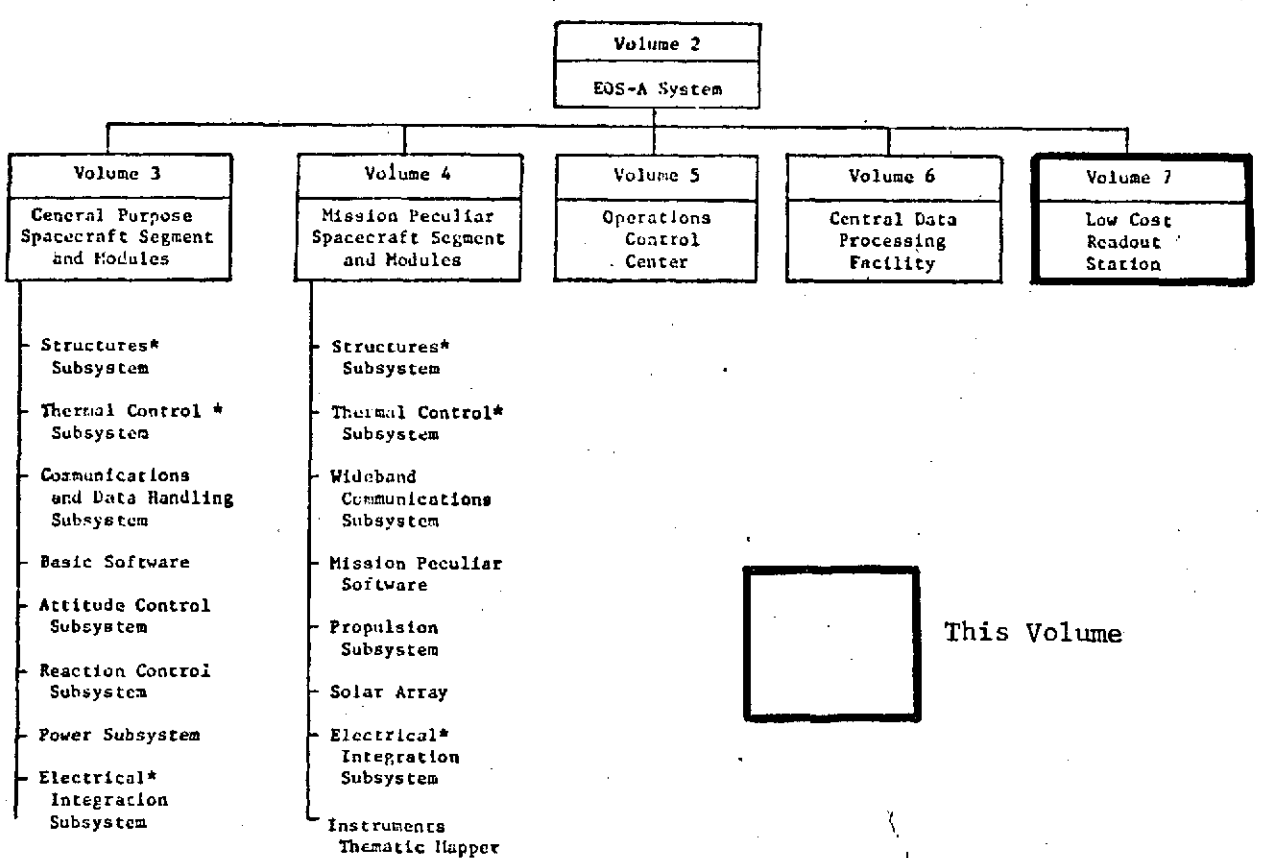
PREFACE

This report, "Baseline System Design & Specifications", has been prepared for NASA/GSFC under contract NAS 5-20518 EOS System Definition Study. It describes the system design that has evolved through a series of design/cost tradeoffs to satisfy a spectrum of mission/system requirements. The basic spacecraft design is compatible with many missions. The EOS-A mission, the potential first mission, is used to define the mission peculiar elements of the system.

For convenience this report is bound in separate volumes as follows:

Volume 1	Baseline System Description
Volume 2	EOS-A System Specification
Volume 3	General Purpose Spacecraft Segment and Module Specifications
Volume 4	Mission Peculiar Spacecraft Segment Specification
Volume 5	Operations Control Center Specification
Volume 6	Central Data Processing Facility Specification
Volume 7	Low Cost Ground Station Specification

Volume 1 "Baseline System Description" presents the overall EOS-A system design, a description of each subsystem for the spacecraft, and the major ground system elements. Volumes 2 through 7 present the specifications for the various elements of the EOS system and are organized according to the specification tree as follows:



* These specifications are written as integral specifications for the GPSS and MPSS and appear in Volume 3 only.

Specification No. SVS-XXXX

16 September 1974

SPECIFICATION

FOR THE

EARTH OBSERVATORY SATELLITE (EOS)

LOW COST READOUT STATION (LCRS) SEGMENT

TABLE OF CONTENTS

SECTION 1.0

SCOPE

This specification establishes the functional performance, design and test requirements for the Earth Observatory Satellite (EOS) Low Cost Readout Station (LCRS) Segment.

SECTION 2.0

APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

2.1 SPECIFICATIONS

(TBR)	EOS Project Office/LCRS Interface Control Document
(TBR)	Operations Control Center/LCRS Interface Control Document
(TBR)	EOS Satellite/LCRS Interface Control Document
(TBR)	LCRS Power and Grounding Requirements Interface Control Document
MIL-STD-470	Maintainability Program Requirements (for Systems and Equipments)

2.2 STANDARDS

IRIG 106-69	Telemetry Standards

2.3 OTHER PUBLICATIONS

S-323-P-5A	Quality Assurance Requirements for Standard Industrial Equipment
NPC-200-3	Inspection System for Suppliers of Space Materials, Parts, Components and Services
NPC-250-1	Reliability Program Provisions for Space Systems Contractors

SECTION 3.0

REQUIREMENTS

The functional, performance and design requirements of the Low Cost Readout Station (LCRS) are specified in this section.

3.1 LCRS SEGMENT DEFINITION

The basic Low Cost Readout Station (LCRS) consists of all hardware and software needed to acquire and track the EOS-A or EOS-B Satellite and receive, record, process and annotate the instrument data from the satellites and to provide the appropriate interfaces with the unique local user provided display and extractive processing equipment.

3.1.1 GENERAL REQUIREMENTS

The LCRS shall be capable of acquiring image data from the EOS-A or EOS-B Satellite over a ground area defined by a 500 Km radius from the coordinates of station.

The LCRS shall be capable of receiving and processing both, but not simultaneously, full five band Multispectral Scanner (MSS) image data and various modes of Compacted Thematic (CTM) image data listed below.

Mode	Ground Resolution* (Meters)	Spectral Bands	Swath Width (Percentage)
1	60 m	All 6	100%
2	30 m	All 6	25%
3	30 m	Any 3 of the first 5 + band 6	50%
4	30 m	Any 1 of the first 5 + band 6	100%

* Applies to bands 1 through 5, band 6 has 120 meter ground resolution

The LCRS shall consist of a Data Acquisition Subsystem, a Data Processing and Correction Subsystem and a Data Display and Extractive Processing Subsystem. The Data Acquisition Subsystem and the Data Processing and Correction Subsystem shall form the basic LCRS; the Data Display and Extractive Processing Subsystem shall be tailored to the unique requirements of the local user.

The basic LCRS shall be capable of generating the following output products:

a. Nine-track IBM computer compatible tapes (CCT's) containing the processed and corrected image data,

b. Processed and corrected image data to the local user for visual display during generation of the CCT's or during playback of CCT's, and

c. Processed and corrected image data to the local user for film recording during playback of CCT's at reduced speeds compatible with local user film recording equipment.

3.1.2 FUNCTIONS

The LCRS shall perform the following major functions

a. Date Acquisition

b. Data Processing and Correction, and

c. Data Display and Extractive Processing

3.1.2.1 Data Acquisition

The LCRS Data Acquisition Subsystem shall be capable of acquiring and tracking the EOS-A and EOS-B Satellites over a period up to 135 seconds by means of a pre-programmed paper tape input produced by the Data Processing and Correction Subsystem. The Data Acquisition Subsystem shall also be capable of receiving the 15 Mb/s image data, identified above, from the fixed wideband satellite antenna and demodulating and recording both the data and clock directly on a fixed head high density digital tape recorder. The high density digital tape recorder shall be capable of playing back the recorded data at reduced rates determined by the recorded date rate of the spectral channel to be processed

and the computation capability of the mini-computer within the Data Processing and Correction Subsystem.

3.1.2.2 Data Processing and Correction

The OCRS Data Processing and Correction Subsystem shall be capable of accepting the recorded image data from the Data Acquisition Subsystem and reconstructing the data and clock signals and demultiplexing the data (one band for each pass through the HDDT). The Data Processing and Correction Subsystem shall be capable also of performing radiometric correction on the input data and data format conversion for producing computer compatible tapes (CCT's) of the corrected image data and simultaneously transferring this data directly to the local user display equipment. The CCT's shall be capable of playback reduction ratios compatible with local user film recording equipment.

3.1.2.3 Data Display and Extractive

The unique LCRS Data Display and Extractive Processing Subsystem shall be capable of displaying the image data and generating photographic images of the data received from the Data Processing and Correction Subsystem. The full functional requirements for this subsystem will be based on the unique requirements for each local user.

3.1.3 INTERFACE DEFINITION

The LCRS shall interface with the EOS Project Office, Operations Control Center and the Low Cost User R/F Link from the EOS-A or EOS-B satellites.

3.1.3.1 EOS Project Office

The local user shall submit requests for transmission of image data from the EOS-A or EOS-B satellites over their area of interest and specify the satellite, the revolution number, the instrument type and where appropriate.

The exchange of data shall be through a telephone line datafax link. The specific format for the data information exchange shall be in accordance with the EOS Project Office/LCRS Interface Control Document (ICD-XXXX)

3.1.3.2 Operations Control Center

The Operations Control Center shall provide to the local user, at time of activation of the Low Cost Readout Station, with predicted ground antenna contact profiles as a function of time in form of a computer listing for the satellite orbits over the local user coverage area based on coordinates of the ground antenna and the nominal spacecraft orbit parameters.

The Operations Control Center shall provide, periodically, local coverage schedules to the local users for their area of interest on which the local users will establish their requests for transmission of image data from the satellites.

Confirmation of local user requests shall be provided by the Operations Control Center in the form of predicted spacecraft acquisition time and position, period of transmission over the requested area, and instrument data and mode to be transmitted

The exchange of data shall be through a telephone line datafax link. The specific formats for the data information exchange shall be in accordance with OCC/LCRS Interface Control Document (ICD-XXXX).

3.1.3.3 EOS Satellite Low Cost User R/F Link

The EOS-A and EOS-B Satellites shall provide, to the LCRS, the MSS and CTM instrument data via the satellite low cost user fixed wide beam wide band antenna.

The characteristic and specifications of this interface shall be in accordance with EOS Satellite/LCRS Interface Control Document (ICD-XXXX).

3.2 CHARACTERISTICS

3.2.1 PERFORMANCE

The OCRS shall consist of the following subsystems as listed below and shown on Figure 3.2-1.

a. Data Acquisition Subsystem
b. Data Processing and Correction Subsystem
c. Data Display and Extractive Processing Subsystem

The performance requirements for the LCRS Subsystem and their major components are specified in this section.

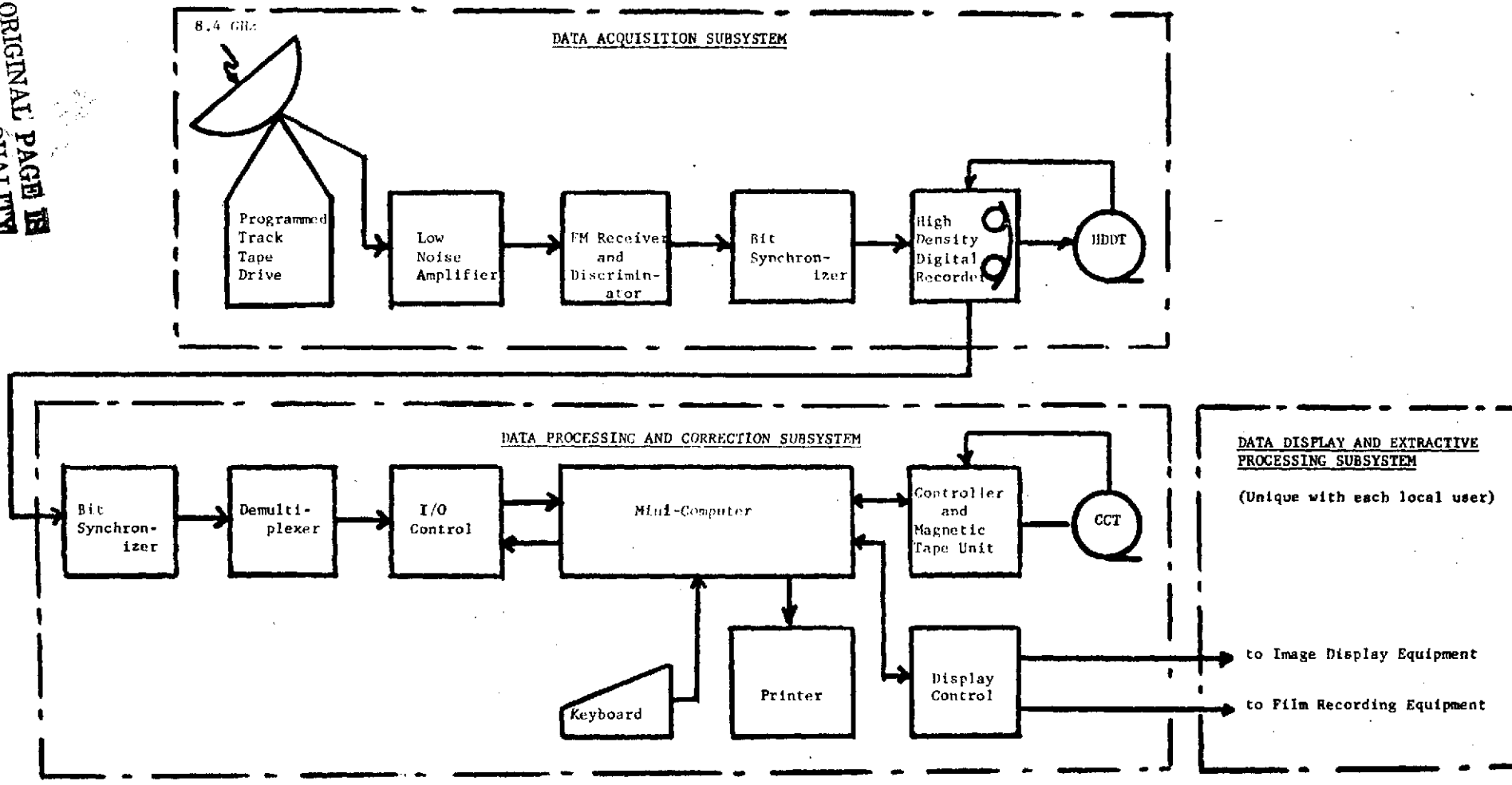


Figure 3.2-1. Low Cost Readout Station System/Subsystem Block Diagram

3.2.1.1 Data Acquisition Subsystem

The Data Acquisition Subsystem (DAS/S) shall perform the following functions:

a. Receive the X-band signal from the EOS-A or EOS-B Satellite

b. Track the EOS satellite during signal reception so as to maintain BER within allowable limits (10^{-5} under worst case conditions)

c. Pre-amplify the received R/F signal for transmission by hard wire to the receiver

d. Detect and demodulate the R/F signal to extract the 15 Mb/s data

e. Condition and format the digital data

f. Record the digital data on a high density digital recorder

g. Play back the recorded data to the Data Processing and Correction Subsystem at data rates compatible with the mini-computer computational capacity

The DAS/S shall contain, at least, the following components:

a. X-band Antenna and Drive Unit

b. Low Noise Pre-amplifier

c. FM Receiver and Discriminator

d. Bit Synchronizer

e. High Density Digital Recorder

3.2.1.1.1 Performance Requirements

The components of the DAS/S shall meet the specifications provided below:

A. X-Band Antenna and Drive Unit: The characteristics and capabilities of the X-Band Antenna and Drive Unit shall be as follows:

a. Gain $\geq$ 42 dB (diameter = 1.8 meters)

b. Operating Frequency = 8.377 GHz (nominal)

c. Power Flux Density Range: -143 to -156 dBW/m^2/4 kHz

d. Circular Polarization: (TBR)

e. Antenna Drive Control: Paper Tape Programmed Control

f. Antenna Static Position Accuracy $\leq 0.1^{o}$

g. Antenna Tracking Rate $\leq 0.55^{o}$/sec maximum

h. Antenna Tracking Accuracy $\leq 0.3^{o}$

i. Antenna Angular Coverage: 30 to 90^{o} in all directions

j. Other: Provide for direct mounting of LNA on reflector

B. Low Noise Amplifier: The characteristics and capabilities of the low noise amplifier (LNA) shall be as follows:

a. Type: Uncooled paramp

b. Effective Temperature $\leq 150^{o}$ @ end-of-life

c. Operating Frequency = 8.377 GHz (nominal)

d. Bandwidth $\geq$ 30 MHz

e. Gain $\geq$ 25 dB

f. Output: Flexible coaxial cable to receiver

C. Receiver: The characteristics and capabilities of the receiver shall be as follows:

a. Input Signal Frequency = 8.377 GHz (nominal)

b. Intermediate Frequency = (TBD)

c. Local Oscillator: Manually Adjustable ($\pm$5 MHz minimum)

d. Tuning Indicator: Visual

e. Bandwidth $\geq$ 30 MHz

f. Detector: FM Discriminator

g. Gain $\geq$ 75 dB

h. Noise Figure $\leq$ 6.5 dB

i. AGC: As Required

j. Input Terminal: Coaxial

k. Output Terminal: (TBD - Adapt to bit synchronizer requirement)

D. Bit Synchronizer: The characteristics and capabilities of the bit synchronizer shall be as follows:

a. Code Type: NRZ-L (per IRIG 106-69)

b. Bit Rate: 15 Mb/s

c. Center Frequency Stability $\leq$ 0.1% of Bit Rate

d. Acquisition: Within 1000 bit times for SNR's $\geq$ 12 dB

e. Control: Provides for logic inversion of serial data output

f. Slippage $\leq 1 \times 10^{-6}$ for SNR's $\geq$ 12 dB

g. Output: Capable of driving 50.0 ohm coaxial cable; output levels compatible with TTL logic

E. High Density Digital Recorder: The characteristics and capabilities of the high density digital recorder shall be as follows:

a. Type: Linear multi-track recorder with 14 channels capable of recording on a 14 inch reel of 1" wide tape

b. Channel Assignment: Eleven for data, three for auxiliary information (e.g., time code, voice annotation)

c. Record Rates: 15 Mb/s @ 120 ips

d. Play Back Rates: Selectable up to 1:64 of record rate

e. Packing Density: Up to 20,000 bits per inch per track

f. Bit Error Rate $\leq 1 \times 10^{-6}$ from record to read

g. Packaging: Record and playback electronics shall be integral part of HDDR.

3.2.1.1.2 Interface Requirements

The input to the DAS/S shall consist of:

a. X-Band R/F signal from EOS Satellite low cost user fixed beam antenna

- o Frequency = 8.377 GHz nominal
- o Bandwidth = 30 MHz
- o Power Flux Density Range: -143 to -156 $dBW/m^2/4$ kHz

- o Modulation: PCM-FM
- o Polarization: Circular

b. Punched paper tape to control antenna tracking.

The output from the DAS shall be the clean recorded digital CTM or MSS instrument data at playback ratios up to 1:64.

3.2.1.2 Data Processing and Correction Subsystem

The Data Processing and Correction Subsystem (DPCS/S) shall utilize the HDDR specified under paragraph 3.2.1.1.1 in the playback mode with playback ratios up to 1:64. The DPCS/S shall perform the following functions:

a. Buffer, format, and clock data for input to mini-computer

b. Separate scene imagery into individual spectral channels

c. Apply radiometric correction on an element by element basis to the selected individual channel

d. Format corrected imagery data and record on CCT via magnetic tape unit

e. Provide corrected imagery data in a format suitable for input to an imagery display system either during generation of the CCT or during playback of the CCT

f. Provide corrected imagery data in a format suitable for input to a film recording system during playback of CCT's at reduced speeds compatible with local user film recording equipment.

The DPCS/S shall contain, at least, the following components:

a. Bit Synchronizer

b. Demultiplexer

c. I/O Control Unit

d. Mini-computer

e. Controller and Magnetic Tape Unit

f. Display Control

g. Peripherial equipment consisting of a keyboard/printer unti with a punch paper tape unit, and an output line printer unit

h. Software consisting of:

1. Executive
2. Radiometric Correction Module
3. CCT Production Module
4. Display Output Module
5. Peripheral Control Modules

3.2.1.2.1 Performance Requirements

The components of the DPCS/S shall meet the specifications provided below:

A. Bit Synchronizer: The characteristics and capabilities of the bit synchronizer shall be as follows:

a. Code Type: NRZ-L (per IRIG 106-69)

b. Bit Rate: Selectable from 0.25 Mb/s to 2 Mb/s

c. Center Frequency Stability $\leq$ 0.1% of bit rate

d. Acquisition: Within 1000 bit times for SNR $\geq$ 12 dB

e. Control: Provides for logic inversion of serial data output

f. Slippage $\leq 1 \times 10^{-6}$ for SNR's $\geq$ 12 dB

g. Output: Capable of driving 50.0 ohm coaxial cable; output levels compatible with TTL logic

B. Demultiplexer: The characteristics and capabilities of the demultiplexer shall be as follows:

a. Input: Serial PCM data and clock from the bit synchronizer

b. Capability: Decommutates image and calibration data, time, line length and frame ID codes

c. Output: Parallel output data of selected spectral band to I/O control unit for reformatting

C. I/O Control: The characteristics and capabilities of the I/O control unit shall be as follows:

a. Input: Parallel output data of selected spectral band from the demultiplexer

b. Capability: Data reformatting of input data and buffering between demultiplexer and mini-computer

c. Output: Byte stream on a per detector basis to the mini-computer

D. Mini-computer: The characteristics and capabilities of the mini-computer shall be as follows:

a. Minimum word size: 16 bits

b. Minimum Memory Size: 16,384 full computer words

c. Minimum Hardware General Purpose Addressable Registers: 2

d. Maximum Memory Cycle Time: 1.0 microsecond

e. Direct Memory Access Feature with Minimum Transfer Rate of 1 Meg Computer Words per Second

f. Automatic program load (hardware boot strap) from magnetic tape

g. Hardware implemented, signed, add, subtract, multiply, and divide operations

h. Power failure interrupt feature with core memory protected during power failure and with automatic restart capability

i. Operators console, allowing operator to manually start and stop programs, examine and change the contents of memory as well as addressable registers; and step through programs one instruction at a time

j. All interfaces for peripheral devices must plug in modules

k. Priority vectored interrupt feature with a minimum of 16 levels allowing hardware priority assignment of all peripheral devices

l. Additional unused input/output expansion capability, both electrical and physical, shall be provided for additional peripheral devices and spare printed circuit card slots

m. All interface circuitry shall be designed to prevent a peripheral device from adversely affecting the computer when the device is turned off

n. A complete set of all jumper cables, connectors or other equipment necessary to perform or exercise diagnostic programs.

E. Controller and Magnetic Tape Unit: The characteristics and capabilities of the controller and magnetic tape unit shall be as follows:

a. System must be controlled by the software operating system

b. Record and reproduce records on 1/2" magnetic tape in standard 9-track, 1600 bpi, IBM compatible format

c. Minimum record and reproduce transport speed of 75 ips

d. Handle tape reel sizes of 7" and 10-1/2" diameter

e. Minimum tape rewind rate of 150" per second

f. Manual front panel controls shall be provided for, winding tape in the forward and reverse directions, switching transport power on/off, and winding tape forward to the load point.

g. Each recorded block shall include provisions for checking that block for errors, including type parity and sum check

h. Unit shall be rack-mounted in the system enclosure

i. Data and programs stored on tape shall be protected during power failures

j. Direct memory access data transfer to and from tape

k. Provide computer interface and controller

l. Write-protect feature shall prevent writing on tapes that do not have write-protect ring installed

m. Provide indicator lights that monitor "load points", "write enable", and "on line/off line" conditions

n. Detect slack or broken tape, halting tape transport and flagging computer

o. Provide read-after-write error checking of all written blocks; with automatic backspace and record rewrite if error detected. The backspace and rewrite shall be accomplished by a software routine

p. EOT mark sensing, stopping forward tape motion, and flagging the computer.

F. Display Control: The characteristics and capabilities of the display control unit shall be as follows:

a. Input: Corrected image digital data from the mini-computer

b. Capability: Format, buffer and control image data for interfacing with user equipment

c. Output: Corrected image digital data with appropriate throughput properties of the unique local user image display system and film recording systems.

G. Keyboard/Printer: The characteristics and capabilities of the keyboard/printer shall be as follows:

a. Unit shall be a quiet, solid-state electronic type designed for heavy duty application

b. Unit shall have an 80 character per line printing format

c. Unit shall use an eight-level ASC II code communication format

d. Unit shall be capable of printing the 64 character ASC II set of alpha-numerics and symbols; the unit shall have the capability of transmitting the 32 control codes of the ASC II set

e. Unit shall have a minimum communications speed of 110 bands

f. Unit shall include a punch paper tape reader and punch.

H. Line Printer: The characteristics and capabilities of the line printer shall be as follows:

a. Interface compatible with and controlled by the mini-computer

b. Type: Impact rotating drum

c. Input Byte Size: 8 bits

d. No. of Alpha-numerics: 56

e. No. of columns: 132

f. Input buffer size: 1 full line

g. Speed: TBD

I. Software: The computer software shall consist of an execitive and software modules to provide process control, operations support and utility support functions as defined below:

a. Process Control Functions

Two modes of production process control shall be provided:

1) High Density Digital Tape (HDDT) to Computer Compatible Tape (CCT) and user image display

2) CCT to user image display system or user film recording system

For the HDDT to CCT process mode, a radiometric correction function shall also be provided. The two production modes shall be controlled by ancilliary time code data. The output data shall be identified for proper cataloging.

The realtime process control function shall process the data one band at a time, by consecutive lines (detector/sensor). The operations required for a line of data are:

1) Input the ancilliary and sensor data

2) Compute a radiometric correction table using calibration coefficients

3) Radiometrically correct the sensor data (HDDT to CCT mode).

4) Control, format and direct the output media

5) Monitor peripheral status

b. Operations Support Function

The Data Acquisition Subsystem requires information to program the antenna during image passes. The mini-computer system shall provide this data on punch paper tape based on ground antenna contact profile provided by the EOS Project Office. The mini-computer system shall be designed to generate and maintain a data base to provide all the necessary information for acquisition, process control and output cataloguing requirements.

c. Utility Support Function

The mini-computer system shall include the necessary software for system and program update and maintenance as provided by the computer vendor. Standard utility functions for dumping and hardware/software trouble shooting shall be provided for system integrity.

3.2.1.2.2 Interface Requirements

The input to the DPCS/S shall be the clean recorded digital CTM or MSS instrument data at playback ratios determined by the recorded data rate of the spectral channel to be processed and the computational capacity of the mini-computer system within the DPCS/S.

The DPCS/S shall provide the following outputs:

a. Nine-track IBM computer compatible tapes (CCT's) containing the processed and corrected image data

b. Processed and corrected image data to the local user for visual display during generation of the CCT's or during playback of the CCT's

c. Processed and corrected image data to the local user for film recording during playback of the CCT's at reduced rates compatible with the local user film recording equipment

3.2.1.3 Data Display and Extractive Processing Subsystem

The Data Display and Extractive Processing Subsystem (DDEPS/S) shall be unique to each local user station. The primary function to be performed by this subsystem shall include:

a. Image display

b. Film recording

c. Image analysis

Data outputs to the DDEPS/S shall be provided by the display control unit within the DPCS/S under the control of the mini-computer system.

3.2.1.3.1 Performance (TBD)

(Note: To be established in conjunction with the local user based on his unique requirements for the DDEPS/S.)

3.2.1.3.2 Interfaces (TBD)

(Note: To be established based on the unique image display equipment and film recording equipment selected by the local user.)

3.2.2 RELIABILITY

MTBF and MTTR factors shall be a consideration in the design and selection of CDPF equipment. A reliability/maintainability program shall be implemented in accordance with selected requirements of NPC 250-1 and MIL-STD-470 as defined in the LCRS R/M Program Plan (TBR).

3.2.3 MAINTAINABILITY

LCRS equipment shall be designed to provide accessability and replaceability consistent with requirements for maintenance and servicing, testing, fault isolation and repairing.

3.2.3.1 Service and Access

Sufficient access shall be provided to enable visual and manipulative maintenance servicing and test tasks. Access covers are permitted when required and shall be designed for easy removal.

Where access is obtained via sliding, rotating or hinged units, such units shall be free to open or rotate their full distance and remain in their open position without requiring support by hand. Further, the equipment from which such units are extended to reach their open position shall remain stable (i.e., not subject to tipping over) when said units are extended.

3.2.3.2 Installation and Removal

The equipment shall be so designed that it can be easily installed, removed, and re-installed with a minimum of special tools and without extensive disassembly.

3.2.4 USEFUL LIFE

The equipment shall be designed for an operating life of 5,000 hours over a 3-year period following acceptance. Normal maintenance and routine replacement

of consumable (known limited life) parts and materials during scheduled maintenance, tune-up and calibration periods shall be permitted.

3.2.5 ENVIRONMENTAL CONDITIONS

Operating and non-operating conditions for LCRS equipment located in non-sheltered and sheltered environments are outlined below. The LCRS equipment considered in a non-sheltered environment include the X-band antenna and drive unit, the low noise amplifier and the interfacing cabling; all other LCRS equipment is considered in a sheltered environment.

3.2.5.1 Non-Operating Conditions

The non-sheltered equipment shall withstand in a stowed condition, and subsequently operate, after exposure to the following environments:

a. Temperature: $-45^{o}C$ to $+55^{o}C$

b. Wind: Up to 200 km/hr

c. Precipitation: Up to 80 mm/hr

d. Static Load: 2.5 cm radial ice and 45 cm vertical snowfall

The sheltered equipment shall withstand, and subsequently operate, after exposure to the following environment:

a. Temperature: $-7^{o}C$ to $38^{o}C$

b. Humidity: 10 to 95%

3.2.5.2 Operating Conditions

The non-sheltered equipment shall operate to requirements of this specification during exposure to the environment below:

a. Temperature: $-35^{o}C$ to $+45^{o}C$

b. Wind: Up to 85 km/hr

c. Precipitation: Up to 25 mm/hr rain or 6 mm/hr freezing rain or 100 mm/hr snow

d. Static Load: Up to 6 mm/hr radial ice or 100 mm vertical snowfall

e. Humidity: 0 to 100%

The sheltered equipment shall operate to the requirements of this specification during exposure to environment below:

a. Temperature: $22^{o} \pm 3^{o}C$

b. Temperature Change: Up to $3^{o}C$/30 minutes

c. Humidity: $55 \pm 15\%$

d. Humidity Change: Up to 15%/30 minutes

3.2.6 TRANSPORTABILITY

The LCRS equipment shall be transported to the user selected site using commercial transportation and air ride vans were considered necessary. Suitable transportability requirements shall be placed on the packaged/protected equipment configuration to assure its safe arrival at the user selected site to avoid placing undue requirements on the LCRS equipment.

3.3 DESIGN AND CONSTRUCTION

The requirements outlined in this section apply to equipment identified as "New Designs"; the requirements do not apply to equipment identified as commercial "off-the-shelf" equipment in which case S-323-P-5A shall apply.

3.3.1 MATERIALS, PROCESSES, AND PARTS

MS, AN, MIL Standards, and commercial materials and parts are acceptable for use in the LCRS with MIL Standard parts usage preferred.

3.3.2 ELECTROMAGNETIC RADIATION

Control of electromagnetic interference within the LCRS shall be effected in an efficient manner during design of the LCRS. The self compatibility of the LCRS equipment shall be demonstrated at the subsystem or subcontractor level

prior to delivery, where possible and practible, and again as a total system after installation. EMC problems, if any, uncovered during tests either prior to or after final installation shall be corrected on an individual basis.

3.3.3 IDENTIFICATION AND MARKING

All assemblies and subassemblies shall be marked with an identifying number and, if space permits, the manufacturer's identification and component nomenclature. Electrical parts shall be labeled with reference designations in accordance with accepted practices to permit easy identification.

3.3.4 WORKMANSHIP

All LCRS equipment shall be constructed to the highest commercial quality manufacturing standards and workmanship practices, consistent with commercial and design limitations which meet S-323-P-5A requirements as a minimum.

3.3.5 INTERCHANGEABILITY

All printed circuit boards, assemblies, modules, etc., shall be directly interchangeable with like units from the manufacturer. Equipment shall be designed to facilitate replacement of units. Where possible, use shall be made of the same module, assembly, etc., in different parts of a subsystem.

3.3.6 SAFETY

The design and development of the equipment shall provide fail-safe features for safety of personnel during the installation, operation, maintenance, and repair of interchanging of a complete equipment assembly or component parts thereof.

3.3.6.1 Electrical Safety Provisions

1) The design shall incorporate methods to protect personnel from accidental contact with voltages in excess of 30 volts root mean square (rms) or

direct current (dc) while operating equipment. Means shall be provided so that power may be cut off while installing, replacing, or interchanging a complete equipment, assembly, or part thereof.

2) Exposure to voltages in excess of 500 volts shall be prevented when cases and seals are removed for maintenance and repair. Equipment access doors or covers shall be provided with interlocks to remove all potential in excess of 150 volts.

3) Equipment shall be designed so that all external parts will be at ground potential. The path to ground for equipment shall be continuous and permanent when connected to facility and the interfacing equipment. Grounding shall be in accordance with LCRS Power and Grounding Interface Control Document (ICD-TRB).

3.3.6.2 Mechanical Safety Provisions

The design of the equipment shall be such as to provide maximum convenience and safety to personnel while installing, operating and maintaining the equipment. Suitable protection shall be provided to prevent contact with moving mechanical parts such as gears, fans, and belts when the equipment is complete and operating. Sharp projections on cabinets, doors, and similar parts shall be avoided.

Equipment design shall include provision to prevent accidental pulling out of drawers or rackmounted equipment components, or inadvertant tipping when pulling out drawers which could cause equipment damage and injury to personnel. Equipment power switches shall be designed and located that accidental contact by personnel will not place equipment in operation.

3.3.6.3 Temperature Conditions

Where people are involved, and under any condition of operation, exposed parts, including the enclosure of the equipment, shall not achieve a temperature in excess of 60°C at an ambient temperature of 22°C. The temperature of front panels and operating controls shall not exceed 38°C at the same ambient temperature.

3.3.6.4 Materials

The materials used in the LCRS operations, as well as that in the equipment, shall not create conditions or products which, when combined with the atmosphere or alone, are toxic, corrosive, flammable, or explosive and detrimental to the performance of the equipment or health and safety of personnel.

3.3.6.5 Chemical Safety

Equipment using chemicals in LCRS shall be designed to protect personnel, equipment, and the LCRS against leakage or accidental spillage during operation of the facility. Where chemicals hazardous to personnel are used, appropriate warning signs shall be placed on the equipment and in the hazardous areas.

3.3.7 HUMAN PERFORMANCE/HUMAN ENGINEERING

The equipment design shall incorporate human engineering principles and practices to insure that satisfactory performance can be achieved by the operating and maintenance personnel, that skill requirements and training time are minimized, and that the reliability of the personnel-equipment combination are at a maximum.

3.3.7.1 Equipment Configuration

LCRS equipment shall be designed to facilitate identification of subassemblies and to protect against improper mounting and installation.

Control panels shall be laid out to provide ease of operation and labeled with titles of non-ambiguity with respect to function.

3.3.7.2 Adjustments

Design of all LCRS equipment shall consider human performance parameters in the adjustment methods used.

3.3.7.3 Visual Displays

Visual displays shall provide the operator with a clear and readable (to the granularity needed) indication of equipment or system conditions.

3.3.8 ELECTRICAL

3.3.8.1 Input Power and Regulation

Voltage:	115 V ± 10% single phase 208 V ± 10% 3-phase, 4-wire
Frequency:	60 Hz ± 2% Δf 1%/Max.
Power:	(TBR)

3.3.8.2 Balancing of Loads

Equipment using 3-phase power in the LCRS shall present balanced loading of ±10% of nominal phase.

3.3.8.3 Utility Bus

The LCRS equipment shall not be operated from the utility power bus.

3.3.8.4 Grounding

Grounding of all LCRS equipment shall be as defined in the LCRS Power and Ground Requirements Interface Control Document (ICD-TBR).

3.3.8.5 Outlets

At least one convenience outlet shall be supplied on each LCRS equipment unit.

3.3.8.6 Overload Protection

Fuses, circuit breakers, thermal overload relays, cutouts, etc., shall be used to provide overload protection for primary power circuits on each LCRS equipment.

3.3.8.7 Elapsed Time Indicators

An elapsed time indicator shall be provided on power operated equipment to indicate elapsed operating time.

3.3.8.8 Test Points

Units which are not completely self-checking shall be provided with appropriate test points, easily accessible, in standard crimp-on connector or test jack form. The test points provided shall be sufficient to isolate trouble in the equipment down to a removable subassembly.

SECTION 4

QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

A Quality Assurance and Configuration Management Program shall be implemented in accordance with the requirements of NPC200-3, GSFC S-323-P-5A, and GMI 8040.1. The QA and CM Program Plan is subject to GSFC approval.

The requirements of Section 3 of this specification shall be verified by one or more of the following methods as specified herein.

4.1.1 INSPECTION

The inspection items identified in Section 4.2 shall be verified by an inspection of the equipment to the requirements as specified in applicable engineering drawings, standards, and specifications that result from the detailed design effort. Proper translation of these requirements into the drawings shall be verified through design review and routine design efforts. For those items which cannot be verified by inspection of the fully assembled items, this verification shall be accomplished at the appropriate lower level of assembly.

4.1.2 ANALYSIS

The analysis items identified in Section 4.2 shall be verified by analysis, as defined below:

1) Reliability - selective MTBF and MTTR analysis shall be conducted to identify potential weaknesses in the design.

4.1.3 DEMONSTRATIONS

The demonstration items identified in Section 4.2 shall be verified by demonstration. These demonstrations shall be considered to have been satisfied upon completion of System Demonstration described in Paragraph 4.1.4.4.

4.1.4 TESTS

The test items identified in Section 4.2 shall be verified by tests as defined herein.

4.1.4.1 Component or Unit Level Tests

Component level tests shall be conducted to verify compliance with performance requirements established in lower level specifications.

4.1.4.2 Subsystem Level Tests

Subsystem level tests shall be conducted in accordance with GE-SSO and GSFC approved test plans and procedures to verify compliance with performance requirements established in subsystem level specifications.

4.1.4.3 Segment Tests

Compatibility testing and operational testing shall be conducted at the LCRS Facility in accordance with approved Segment Test plans and procedures to demonstrate the design compatibility between the LCRS Subsystems and LCRS Facility.

4.1.4.4 System Demonstration

The system demonstration shall be conducted at the LCRS Facility in accordance with approved test plans and procedures using the actual MSS and CTM instrument data received via the low cost user R/F link from an EOS-A or EOS-B Satellite in orbit.

4.2 VERIFICATION MATRIX (TBR)